



U.S. Fish & Wildlife Service

National Elk Refuge

Bibliography

The following bibliography contains published and unpublished articles of research related to the biology, diseases, migration, ecology, etc., of Rocky Mountain Elk and the elk of the National Elk Refuge. The National Elk Refuge **DOES NOT** maintain a library of these articles. Contact your local public or university libraries for assistance in acquiring manuscripts, journals, or reprints of these references.

General Topics

Robbins, R.L., D.E. Redfearn, and C.P. Stone. 1982. Refuges and elk management. Pages 479-507 in J.W. Thomas and D.E. Towell, editors. Elk of North America: ecology and management. Stackpole Books, Harrisburg, Pennsylvania. A review of the value and management of refuge areas for the conservation of elk. The book chapter includes a historical review of the National Elk Refuge, and information ranging from habitat management, winter feeding, disease, hunting, and transplanting of elk from refuges.

Smith, Bruce L., Eric K. Cole, and David S. Dobkin. 2004. Imperfect Pasture: A Century of Change at the National Elk Refuge in Jackson Hole, Wyoming. 156 pp. U.S. Fish & Wildlife Service & Grand Teton Natural History Association, publ. A historical perspective of plant community conditions on the National Elk Refuge in Jackson Hole, WY. The authors document changes in the vegetation on the NER and explore when and why those changes occurred.

Wilbrecht, J.E. 1982. National Elk Refuge: History and management including use of prescribed fire. Pages 101-113 in J.E. Lotan, editors. Proc. Intermountain and Rocky Mountain Fire Council. Missoula, Montana. Discusses the purpose and values of using prescribed fire in management of the Refuge's grasslands.

Wilbrecht, J.E. and R.L. Robbins. 1979. History of the National Elk Refuge. Pages 248-255 in M.S. Boyce and L.D. Hayden-Wing, editors. North American elk: ecology, behavior, and management. University of Wyoming Press, Laramie, Wyoming. 294pp. A review of the refuge's establishment and early history.

Supplemental Feeding & Nutrition

Oldemeyer, J.L., R.L. Robbins, and B.L. Smith. 1993. Effect of feeding level on elk weights and reproductive success at the National Elk Refuge. Pages 64-68 in Callas, R.L., D.B. Koch, and E.R. Loft, editors. Proceedings of the Western States and Provinces Elk Workshop. California Fish and Game Dep., Eureka, California. Studies conducted from 1976-1982 to test several ration levels of alfalfa pellets and determine weight dynamics and reproductive performance of elk on each ration. This work also established that brucellosis reduces potential reproductive output of elk on the NER by about 7%.

Smith, B.L. 1994. Out-of-season births of elk calves in Wyoming. Prairie Naturalist 26(2):131-136. Documents the occurrence and fate of asynchronous births of elk on the NER and possible reasons for their occurrence, including the role of winter food supplementation.

Smith, B.L. 1998. Antler size and winter mortality of elk: effect of environment, birth year, and parasites. Journal of Mammalogy 79:1038-1044. Studies we've conducted to date showed that supplemental feeding did not produce larger birth weight calves, and was not correlated with first year survival of calves. Next we investigated whether antler size of bull elk was correlated with supplemental feeding or several other environmental variables. Antler size of elk that died of natural causes on the NER each winter were related to age, March and April temperatures during the spring that they grew, and to weather conditions when these elk were in utero. Variation in antler size was not a function of the amount of supplemental feed these elk received.

Smith, B.L. 2001. Winter feeding of elk in western North America. Journal of Wildlife Management 65(2):173-190. *Abstract:* Winter feeding of elk (*Cervus elaphus*) is a topic that has engendered a great deal of debate among wildlife biologists, policy makers, and the general public. The first institutional feeding of elk in North America occurred in Jackson Hole, Wyoming, where several thousand elk are still fed during most winters at the National Elk Refuge. Winter feeding of elk is employed on an annual basis by state agencies in Idaho, Oregon, Utah, Washington, and Wyoming. During 1995-99 an average 31,000 elk were fed in those 5 states at a cost of \$1.6 million. Most feeding programs originated due to conflicts between elk and agricultural uses of historic elk winter range. Wildlife managers generally resorted to feeding to reduce damage by elk to crops and to provide economic benefits of maintaining more elk than diminished winter habitat could sustain. Several negative consequences result from feeding elk. These include (1) the monetary costs of feeding, which divert dollars from other resource programs; (2) excessive herbivory that alters plant community structure and consequently affects the value of habitats near elk feedgrounds to other wildlife species; (3) changes in elk behavior that are of both spatial and philosophical significance; (4) diseases, which are more readily transmitted among densely concentrated animals, threaten the welfare of elk and other species, and shape resource management; and (5) public perceptions that may lead to the devaluing of habitat. These consequences argue for a shift from a production-consumption model of elk management toward management that embraces conservation of all species, maintenance of ecosystem functions, and sustainability of resources. I suggest proactive alternatives to winter feeding, which may avert conflict situations that precipitate public and political pressures to feed elk.

Smith, B.L., R.L. Robbins, and S.H. Anderson. 1997. Early development of supplementally fed, free-ranging elk. Journal of Wildlife Management 61:27-40. Birth weights and neonatal growth rates are reported for 7 cohorts of elk calves. Calf survival was related to cohort birth weight. Variation in developmental traits was not related to supplemental feeding of their mothers or to elk densities, but rather to winter and spring weather conditions when calves were in utero.

Smith, B.L. and J.E. Wilbrecht. 1990. Supplemental winter feeding of elk on the National Elk Refuge, Wyoming. Pages 30-41 in Zahn, M., J Pierce, and R. Johnson, editors. Proceedings of the Western States and Provinces Elk Workshop. Washington Department of Wildlife, Olympia, Washington. An overview of the Refuge feeding program, including feed rates, cost, winter mortality of elk, etc.

Disease

Franson, J.C. and B.L. Smith. 1988. Septicemic pasteurellosis in elk (*Cervus elaphus*) on the National Elk Refuge. Journal of Wildlife Diseases 24(4):715-717. Initial work on mortality attributable to this bacterial disease, which appears to be endemic in NER elk and is periodically epizootic.

Roffe, T., and B.L. Smith. 1992. Tuberculosis. Bugle 9(3):86-92. A review of the epizootic nature of bovine tuberculosis in game-ranch elk during the 1980s and 1990s, and the potential threat of this disease should it spread to wild elk and bison.

Samuel, W.M., D.A. Welch, and B.L. Smith. 1991. Ectoparasites from elk (*Cervus elaphus nelsoni*) of Wyoming with emphasis on psoroptic mange. Journal of Wildlife Diseases 27(3):446-451. Further work to

quantify mite infestations and those individual animals afflicted with scabies. Parasite loads are quantified and the clinical signs of scabies are described.

Samuel, W.M., D.A. Welch, and B.L. Smith. 1991. Ectoparasites from elk (*Cervus elaphus nelsoni*) of Wyoming with emphasis on psoroptic mange. *Journal of Wildlife Diseases* 27(3):446-451. Further work to quantify mite infestations and those individual animals afflicted with scabies. Parasite loads are quantified and the clinical signs of scabies are described.

Smith, B.L. 1985. Scabies and elk mortalities on the National Elk Refuge, Wyoming. Pages 180-194 in Nelson, R.W. , editor. *Proceedings of the Western States and Provinces Elk Workshop, Alberta Fish and Wildlife Division, Edmonton, Alberta, Canada.* Initial work to determine the effect of scabies on elk of the NER, and relationships of scabies prevalence to the feeding program and other environmental variables.

Smith, B.L. and T. Roffe. 1992. Brucellosis in elk. *Bugle* 9(2):71-80. A review of the disease brucellosis, particularly as it applies to the Jackson elk herd and its management on the NER.

Smith, B.L., and T. Roffe. 1994. Diseases among elk of the Yellowstone Ecosystem, U.S.A. Pages 162-166 in W. van Hoven, J. Ebedes, and A. conroy, editors. *Third International Wildlife Ranching Symposium. Center for Wildlife Management, University of Pretoria Press, Pretoria, South Africa.* A review of disease among elk of the Yellowstone Ecosystem during the 20th century. Scabies, septicemic pasteurellosis, and brucellosis are highlighted and their epidemiology and prevalence are related to artificial concentration of elk.

Ecology & Management

Anderson, C.R., D.S. Moody, B.L. Smith, F.G. Lindzey, and R.P. Lanka. 1998. Development and evaluation of sightability models for summer elk surveys. *Journal of Wildlife Management* 62: In press. A sightability model was developed to account for visibility bias in aerial censuses and classifications of elk in the Jackson herd unit. The model was used to correct estimates of the number of elk that summer in Grand Teton National Park.

Bailey, J. R. 1999. A working model to assist in determining initiation of supplemental feeding of elk and a carrying capacity model for the National Elk Refuge, Jackson, Wyoming. M.S. Thesis, University of Wyoming. 83pp. A working model was developed to assist in determining when to initiate supplemental feeding of elk on the National Elk Refuge and on state elk feed grounds. A winter carrying capacity model included parameters of forage production and nutritional values, elk nutritional requirements, and snow effects on availability of forage. The carrying capacity data was incorporated into a model that also included data on bioenergetics, winter body condition indices, and winter fat reserves.

Dieni, S., B.L. Smith, R.L. Rogers, and S.H. Anderson. 2000. Effects of ungulate herbivory on aspen regeneration in northwest Wyoming. *Intermountain Journal of Science* 6(1):49-55. Nine years of sampling of aspen regeneration and growth in stands that had been experimentally clearcut are presented. Stand characteristics inside and outside ungulate exclosures in the clearcut stands indicated that ungulate browsing reduced survival and growth of aspen suckers.

Murie, O. J. 1951. *The Elk of North America*. Stackpole Books, Harrisburg, Pennsylvania, USA. 376pp. This is Murie's classic publication on biology, ecology, and management of elk. Much of the data are drawn from his long-term studies of the Jackson elk herd. From population ecology to behavior and biopolitics, Murie's skill and perceptiveness as an observer of elk were remarkable. Murie first detected brucellosis in elk of the GYA and discussed the relationship of the disease to elk management in this book.

Parker, A.E. 1996. Summer distributions and habitat use of the Jackson elk herd. M.S. Thesis. University of Wyoming, Laramie, Wyoming. Based on several thousand relocations of radiocollared elk, Parker developed GIS maps of summer distributions of elk in Grand Teton and Yellowstone National Parks, and the Teton Wilderness Area. Sampling of plant species composition and other habitat characteristics of telemetry locations were compared to random locations. Parker identified variables that explained habitat use by elk. In particular, she identified possible reasons for differences in elk densities between Yellowstone Park and the Teton Wilderness.

Smith, B.L., and S.H. Anderson. 1996. Patterns of neonatal mortality of elk in northwest Wyoming. Canadian Journal of Zoology 74:1129-1237.

For a sample of 164 radio instrumented elk calves, causes of mortality and their spatial and temporal distributions are reported. 68% of neonatal mortalities resulted from predation and male calves suffered higher mortality than females.

Smith, B.L., and S.H. Anderson. 1998. Juvenile survival and population regulation of the Jackson elk herd. Journal of Wildlife Management 62:1036-1045. This paper reports on the role of juvenile survival in regulation of the Jackson elk herd. High survival rates of Jackson elk (58% for calves and 83% for elk > 1 year old) necessitate the continuation of hunting programs in Grand Teton National Park and the NER.

Smith, B.L., and S.H. Anderson. 2001. Does dispersal help regulate the Jackson elk herd? Wildlife Society Bulletin 29:331-341. Our purpose was to determine whether dispersal of juvenile elk from natal summer ranges (herd segments) contributed to limitation of population size and thereby reduced the need for hunting in Grand Teton National Park. Our results suggested that dispersal out of the Jackson elk herd was not a population-regulating influence and dispersal out of Grand Teton National Park was not a limiting influence on growth of elk numbers in the park. We concluded that at current elk densities, which are artificially maintained by winter feeding, hunting remains a necessary control on elk numbers in Grand Teton National Park.

Smith, B.L., W.P. Burger, and F.J. Singer. 1998. An expandable radio collar for elk calves. Wildlife Society Bulletin 26:113-117. This paper reports on the use, performance, and rate of loss of the radio collars we used to monitor newborn elk calves from several of the studies listed above. Performance of this collar on Jackson elk and Northern Yellowstone elk are presented, with recommendations for collar improvement.

Smith, B.L. and R.L. Robbins. 1994. Migrations and management of the Jackson elk herd. National Biological Survey Resource Paper 199. 61pp. This monograph summarizes the 1978-1984 radio telemetry studies of elk captured on the NER to investigate their seasonal distributions, the locations and timing of their migrations from various summer ranges, natality rates, survival rates and causes of mortality, and changes in the Jackson herd's size in response to various harvest strategies. Location of elk calving areas and spring migrations of elk and bison are viewed in relation to the potential for transmission of brucellosis from elk and bison to cattle.

Smith, B.L., R.L. Robbins, and S.H. Anderson. 1996. Adaptive sex ratios: another example? Journal of Mammalogy 77:818-825. From 164 newborn elk calves that were captured and radio-instrumented from 1990-1992, this paper reviews peripartum sex ratios in relation to variation in elk densities. Findings support the Trivers and Willard hypothesis that as animal densities increase, male:female sex ratios decline.

Various Topics in Popular Publications

Smith, B.L. 1987. Building cooperation. Wyoming Wildlife 51(12): 16. The role of the Jackson Hole Cooperative Elk Studies Group in coordination of research and management of the Jackson elk herd.

Smith, B.L. 1988. Helping nature take its course. Alliance Newsletter 10(3):4-5. Jackson Hole Alliance for Responsible Planning, Jackson, WY. (Now the Jackson Hole Conservation Alliance) A discussion of the ecological values of aspen communities to wildlife and the NER's efforts to conserve and manage aspen communities in the face of excessive herbivory by elk on the NER.

Smith, B.L. 1991. Jackson: The big herds. Bugle 8(4):48-58. (Updated December 2000) A review of the ecology and management of Jackson elk, one of the largest and most migratory of elk herds. Management challenges, including controlling elk numbers and disease, are discussed.

Smith, B.L. 1996. Migratory behavior of the Jackson elk herd. Yellowstone Science 4(3):6-10. Results of almost 20 years of investigation of migratory behavior of the Jackson herd are presented. The reasons and timing of the annual migrations are discussed in the context of management and wildland conservation.

Additional References

Altmann, M. 1952. Social behavior of elk, *Cervus canadensis nelsoni*, in the Jackson Hole area of Wyoming. *Behaviour* 4:116-143.

Altmann, M. 1956. Patterns of herd behavior in free-ranging elk *Cervus canadensis nelsoni*. *Zoologica* 41(2):65-71.

Anderson, C. C. 1958. The elk of Jackson Hole: a review of Jackson elk studies. Wyo. Game and Fish Comm., Cheyenne. Bull. No. 10. 184pp.

Boyce, M. S. 1989. The Jackson elk herd: intensive wildlife management in North America. Cambridge University Press, Cambridge, U.K. 306pp.

Boyce, M. S. 1991. Migratory behavior and management of elk (*Cervus elaphus*). *Appl. Anim. Behav. Sci.* 29:239-250.

Brazda, A. R. 1953. Elk migration patterns and some of the factors affecting movements in the Gallatin River Drainage. *J. Wildl. Manage.* 17:9-23.

Brown, C. 1985. Sand Creek Elk: Population Status, Movements, and Distribution. Id. Dep. Fish and Game Job Completion Rep., Boise. 118pp.

Cole, G. F. 1969. The elk of Grand Teton and Southern Yellowstone National Parks. Nat. Park Serv. Res. Rep. GRTE-N-1. Washington, D.C. 80pp.

Craighead, J. J. 1952. A biological and economic appraisal of the Jackson Hole elk herd. New York Zoological Society and the Conservation Foundation, New York, New York, USA

Craighead, J. J., G. Atwell, and B. W. O'Gara. 1972. Elk migrations in and near Yellowstone National Park. *Wildl. Monogr.* 29. 48pp.

DeByle, N. V. 1985. Wildlife. Pages 135-152 in N. V. DeByle and R. P. Winokur, editors. Aspen: ecology and management in the western United States. USDA Forest Service General Technical Report RM-119. Rocky Mountain Forest and Range Experiment Station, Ft. Collins, Colorado, USA.

Dean, R. E., E. T. Thorne, and I. J. Yorgason. 1976. Weights of Rocky Mountain elk. *Journal of Mammalogy* 57(1):186-189.

Fowler, C. W. 1987. A review of density dependence in populations of large mammals. Pages 401-441 in H. H. Genoways, ed. *Current Mammalogy*. Plenum, New York, USA.

Hart, J. H., and D. L. Hart. 1989. Effect of elk on aspen ecology in rocky Mountain ecosystems. *Bulletin of the Ecological Society of America* 70:134-135.

Houston, D. B. 1968. The Shiras moose in Jackson Hole, Wyoming. Grand Teton Natural History Assoc. Tech. Bull. No. 1. Moose, Wyo. 110pp.

Houston, D. B. 1982. The northern Yellowstone elk. Macmillan Publ. Co., New York. 474pp.

Kay, C. E. 1985. Aspen reproduction in the Yellowstone Park - Jackson Hole area and its relationship to the natural regulation of ungulates. Pages 131-160 in G. W. Workman, editor. *Western elk management: a symposium*. Utah State University, Logan, Utah, USA.

Keiter, R. B., and P. H. Froelicher. 1993. Bison, brucellosis, and law in the Greater Yellowstone Ecosystem. *Land and Water Law Review* 28:1-75.

Krebill, R. G. 1972. Mortality of aspen on the Gros Ventre elk winter range. USDA Forest Service Paper INT-129. 18pp.

Kreeger, T. J., E. S. Williams, and D. J. Money. In Press. *Brucella abortus* and other potential exotic diseases as a threat to indigenous species in the Greater Yellowstone Ecosystem. Fifth Biennial Scientific Conference on the Greater Yellowstone Ecosystem, Yellowstone National Park, Wyoming, USA.

Martinka, C. J. 1969. Population ecology of summer resident elk in Jackson Hole, Wyoming. *J. Wildl. Manage.* 33:465-481.

Muschenheim, A. 1988. Ivermectin for the treatment of psoroptic scabies in elk (*Cervus elaphus nelsoni*) and Rocky Mountain bighorn sheep (*Ovis canadensis canadensis*). M. S. thesis, University of Wyoming, Laramie, Wyoming, USA.

Romme, W. H., M. G. Turner, L. L. Wallace, and J. S. Walker. 1995. Aspen, elk, and fire in northern Yellowstone National Park. *Ecology* 76:2097-2106.

Rudd, W. J., A. L. Ward, and L. L. Irwin. 1983. Do split hunting seasons influence elk migrations from Yellowstone National Park? *Wildl. Soc. Bull.* 11:328-331.

Singer, F. J., A. T. Harting, and K. K. Symonds. 1997. Density-dependence, compensation, and environmental effects on elk calf mortality in Yellowstone National Park: *Journal of Wildlife Management* 61:12-25.

Singer, F. J., W. Schrier, J. Oppenheim, and E. O. Garton. 1989. Drought, fires, and large mammals. *Bioscience* 39:716-722.

Straley, J. H. 1968. Population analysis of ear-tagged elk. *Proc. West. Assoc. State Game and Fish Comm.* 48:152-160.

Toman, T. L., T. Lemke, L. Kuck, B. L. Smith, S. G. Smith, and K. Aune. 1997. Elk in the Greater Yellowstone Area: status and management. Pages 56-64 in E. T. Thorne, M. S. Boyce, P. Nicoletti, and T. J. Kreeger, editors. *Brucellosis, bison, elk, and cattle in the Greater Yellowstone Area: defining the problem, exploring solutions*. Wyoming Game & Fish Dept., Cheyenne, Wyoming, USA.